Yamato 983885

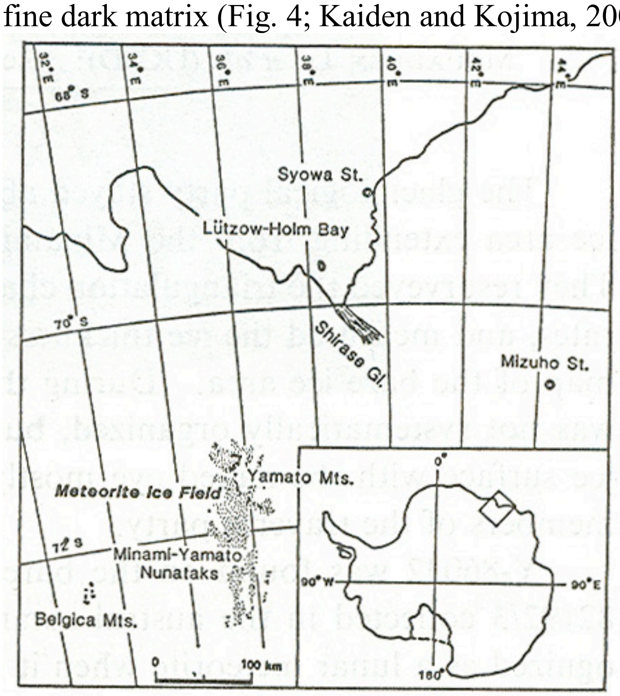
Basalt-bearing anorthositic regolith breccia

288.54 g

Figure 1: Yamato 983885 basalt bearing feldspathic regolith breccia; cube is 1 cm on a side.

Introduction

Yamato 983885 (Fig. 1) was found on bare ice around the Yamato Mountains, on January 11, 1999 during JARE-39 (Fig. 2 and 3). It weighs 288.54 g and has thin yellowish green fusion crust. Angular white and grey clasts and white plagioclase, and darker pyroxene all occur in a fine dark matrix (Fig. 4; Kaiden and Kojima, 2002; 2003).



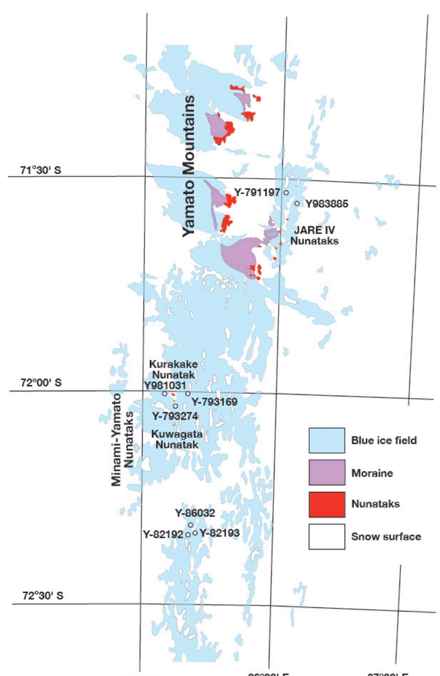


Figure 2: Location map for the Yamato Mountains. Figure 3: Detailed location map for the Yamato lunar meteorites (map courtesy of the NIPR). Y983885 is at the top right of the map.

Figure 4: six different views of Yamato 983885 ; cube is 1 cm on a side.

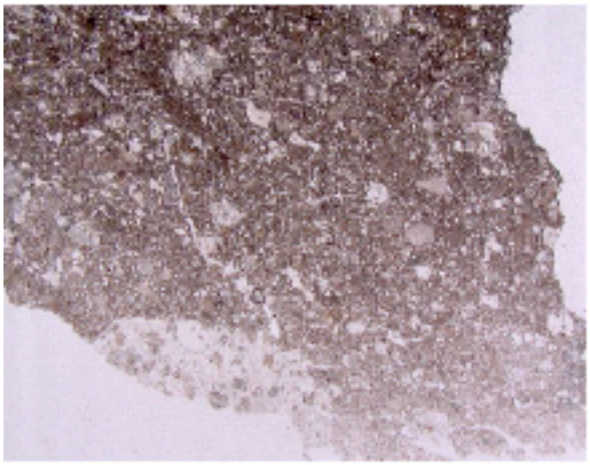


Figure 5: photomicrograph of Yamato 983885 thin section 71-1, illustrating the preponderance of dark matrix and many small clasts. Width is 7.5 mm.

Petrography and Mineralogy

This meteorite is a polymict breccia that contains numerous clasts and mineral fragments in a dark brown matrix (Fig. 5). The clasts include momomineralic and polymineralic types, as well as glass spherules (Kaiden and Kojima, 2002; 2003; Arai et al., 2004, 2005). The polymineralic clasts are troctolite, norite, granulite, KREEP basalt, high Al basalt, and low Ti basalt (Fig. 6 and Table 1). The lithologies are largely of highland origin, but the presence of some basaltic material indicates that this is a mixed breccia with similarities to Calcalong Creek or MET 01210. The fine grained matrix makes up close to 95% of the mode of the rock, as can be seen in two different thin sections (Fig. 5 and 6). A detailed study of six of the clasts by Arai et al. (2005) has led to a thorough understanding of the mineralogy and petrology of this breccia. The narrow compositional range of plagioclase feldspar, pyroxene, and olivine in the small clasts of troctolite, norite, and high Al basalt (Fig. 7 and 9) are shown in Figure 8 and 10. Whereas the much larger compositional range of plagioclase and pyroxene in the low Ti and KREEP basalt (Fig. 11 and 13) are shown in Figures 12 and 14.

Table 1: Modal abundance of each clast in Y983885 (from Arai et al., 2005)

Clast	*Plag.*	*pyrox*	*oliv*	*ilm*	*chrom*	*K-spar*	*Sil+gl*	*Sulf+Met*	*phos*
KREEP	64.1	20.1	-	2.1	-	tr	10.9	-	2.8
Norite	48.8	40.4	10.8	-	-	-	-	-	-
Troct.	59.6	15.5	23.4	-	tr	-	-	1.5	tr
Gran.	91	-	9	-	-	-	-	-	-
Hi Al	75.4	10.6	10.9	-	-	-	-	2.7	0.4
VLT	42.5	53.4	tr	tr	-	-	4.1	-	-

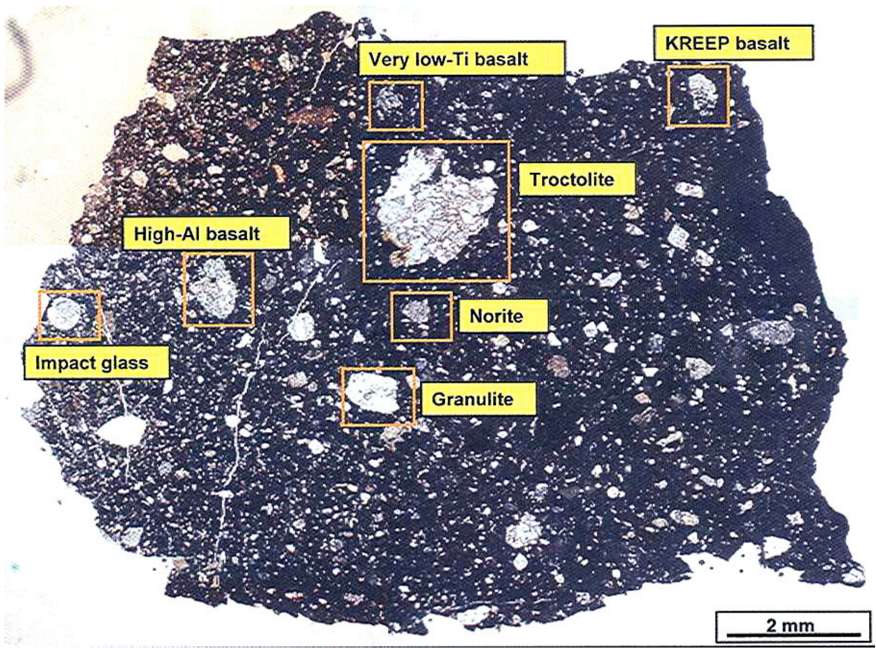


Figure 6: Photomicrograph of thin section 59-2, from the study of Arai et al. (2005), illustrating the diversity of small clast lithologies present in Yamato 983885.

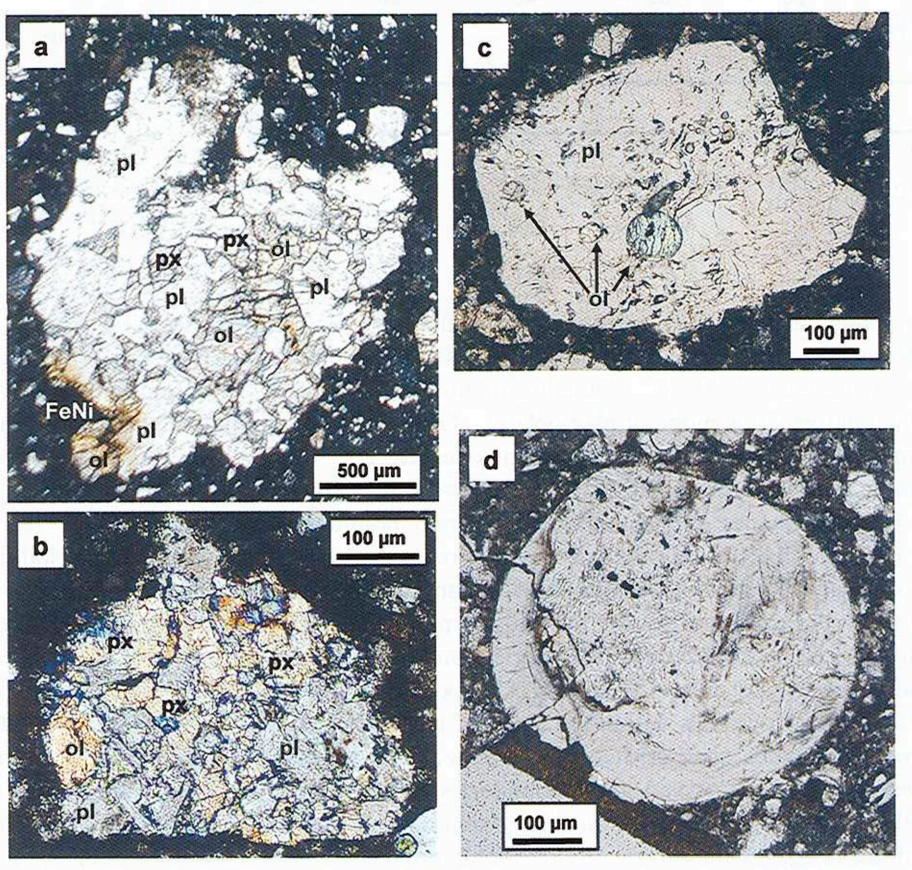
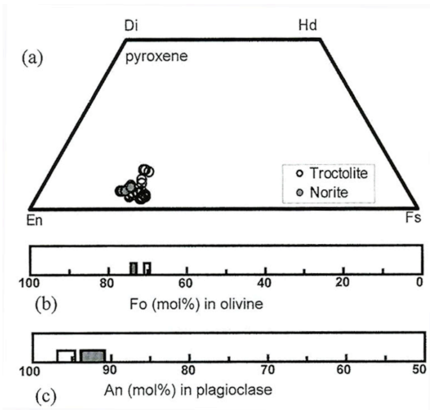


Figure 7: Close up views of four different clasts: a) troctolite, b) norite, c) granulite, and d) impact spherule.



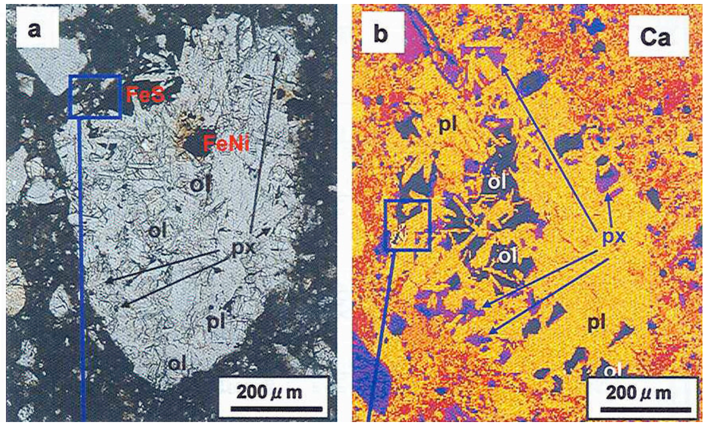
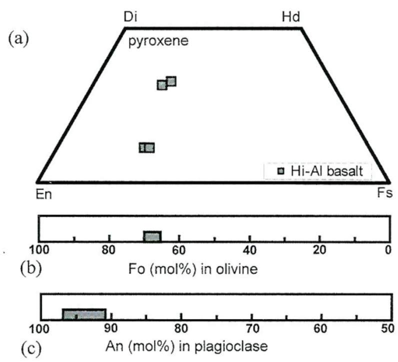


Figure 8: Pyroxene, olivine and plagioclase compositions from the troctolite and norite from Fig. 7. Figure 9: Photomicrograph (a) and Ca x-ray map (b) of high Al basalt clast.



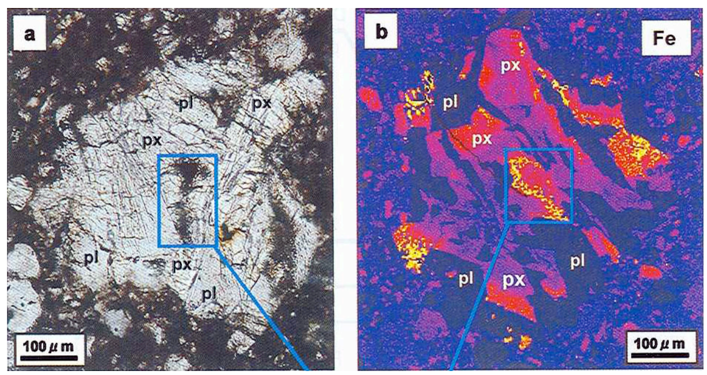


Figure 10: Pyroxene, olivine and plagioclase compositions from the high Al basalt clast of Fig. 9. Figure 11: Photomicrograph and Fe x-ray map of VLT basalt clast. Blue boxes are from the original work, and highlight patches of silica, fayalite, ilmenite and troilite.

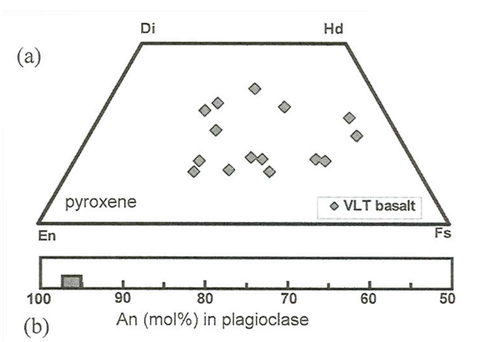
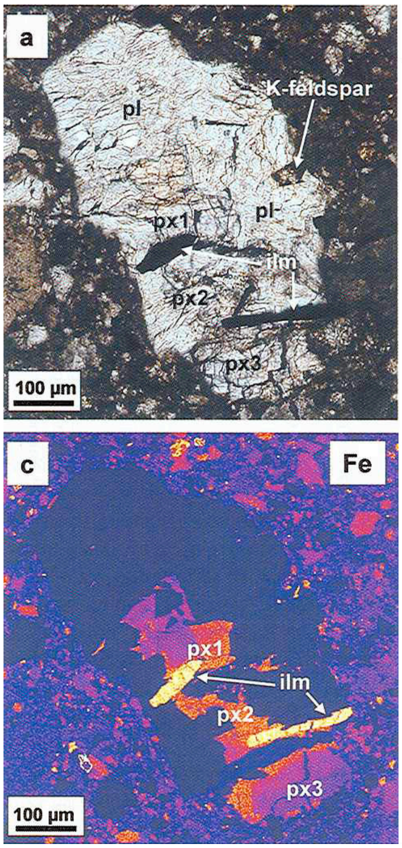


Figure 12: pyroxene and plagioclase compositions from the VLT basalt clast of Figure 11. Note much wider range of pyroxene composition compared to the other plutonic rocks – similar to that observed in Apollo VLT basalts.



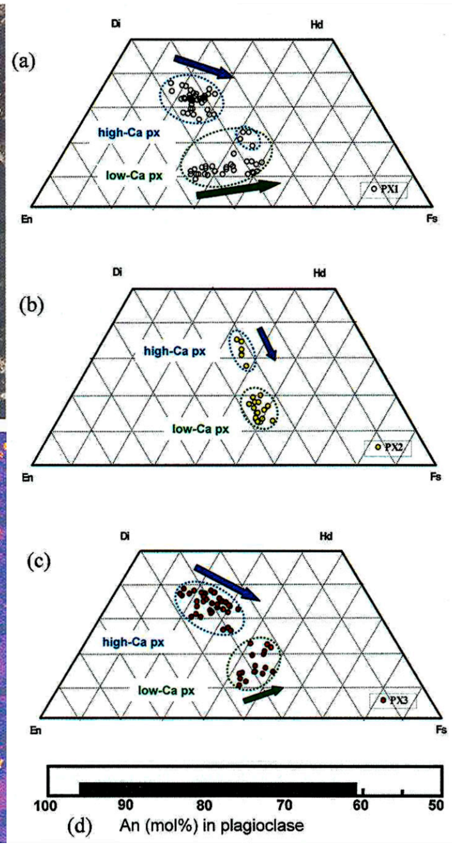


Figure 13: Photomicrograph and Fe x-ray map of KREEP basalt clast. Figure 14: Pyroxene px1, px2 and px3, together with plagioclase compositions from the KREEP basalt clast of Fig. 13.

Chemistry

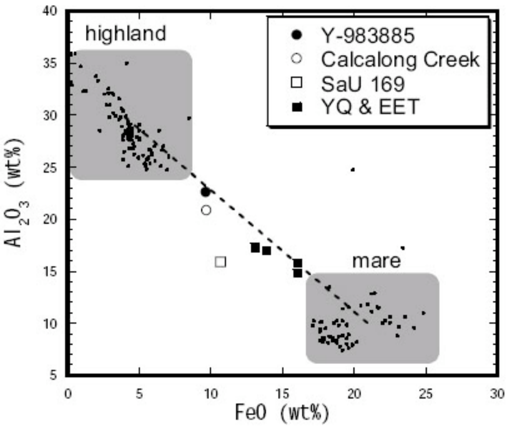
The petrographic evidence for a mixed breccia (dominated by highlands components) is reinforced by the bulk compositional features of Yamato 983885 (Table 2). It has a similar composition to Calcalong Creek, in that it contains 9 to 10 wt% FeO and 21 to 22 wt% Al_2O_3 (Fig. 15). A small KREEP component is evident with its rare earth element concentrations elevated above those of feldspathic breccias such as Y791197, but still lower than the KREEP-rich SaU169 (Fig. 16; Warren and Bridges, 2004). Yamato 983885 also contains high noble gas contents, and a solar wind component suggesting a higher maturity than many other lunar regolith breccia meteorites (Fig. 17; Miura et al., 2006).

Radiometric age dating

No work has yet been published regarding radiometric age dating.

Cosmogenic isotopes and exposure ages

Noble gas contents of Yamato 983885 are high, indicating derivation from a mature regolith (Miura et al., 2006; Lorenzetti et al., 2003). Be, Al, and Cl isotopic measurements have yielded the following history for Yamato 983885: ejection from Moon at 0.045 Ma (Nishiizumi et al., 1994), with a very short Earth-Moon transfer time (< 0.0.02 Ma), and terrestrial age (0.045 Ma).



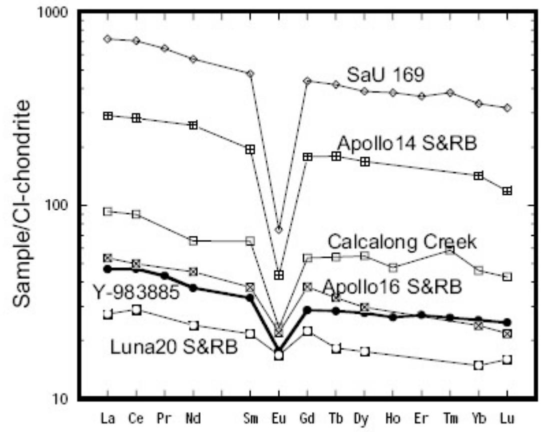


Figure 15: FeO vs. Al_2O_3 for several mingled breccias, including Yamato 983883, from the study of Karouji et al. (2006).

Figure 16: Rare earth element diagram for Y-983885 compared to SaU169, Calcalong Creek, and Apollo 14, 16 and Luna 20 soil and regolith breccias (from Karouji et al., 2006).

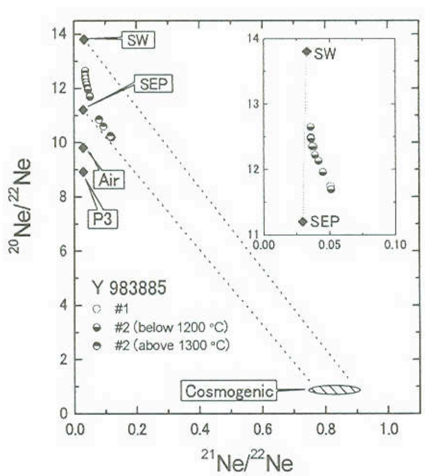


Figure 17: Neon isotopic values for Yamato 983885 (from Miura et al., 2006) illustrating the high solar wind component that is prevalent in all the noble gases for this meteorite.

Table 2. Chemical composition of Yamato 983885 (abbreviated due to small amount of data)

reference	1	2	3
weight (mg)		211	220
method	h	b,c,d,g	g
SiO_2 %	45.59	45.8	
TiO_2	0.53	0.531	
Al_2O_3	21.81	22.6	22.3
FeO	9.41	9.65	
MnO		0.115	0.121
MgO	7.98	9.07	
CaO	14.02	13.8	
Na_2O		0.37	
K_2O		0.166	
P_2O_5			
S %			

sum		
Sc ppm		19.8
V		45
Cr	1347.895	1430
Co		
Ni		
Ir ppb		22
Pt ppb		
Au ppb		
Th ppm	2.37	
U ppm	0.697	

technique (a) ICP-AES, (b) ICP-MS, (c) IPAA, (d) PGA, (e) EMPA, (f) RNAA, (g) INAA, (h) wet chemistry

1) Kaiden and Kojima (2002); 2) Karouji et al (2006) 3) Warren and Bridges (2004)